

# The Influence of Fog on Aerosol Optical Properties

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Aerosol particles are ubiquitous, clouds cover much of the earth. Chances are that clouds and aerosol particles are going to interact in the atmosphere. The results of this interaction can be important for both indirect aerosol forcing, (i.e., how aerosol affects the radiative properties of the cloud) and for direct aerosol forcing (how the aerosol optical properties are affected by cloud processing). Here we consider the second case by looking at the difference in aerosol optical properties between for clear days and for foggy days.

Results are presented primarily for the AMF deployment at Point Reyes (PYE) in July 2005. A similar experiment will commence at Holme Moss (north of Manchester) in the UK on November 1, 2006 with the added advantage of enhanced cloud property measurements.

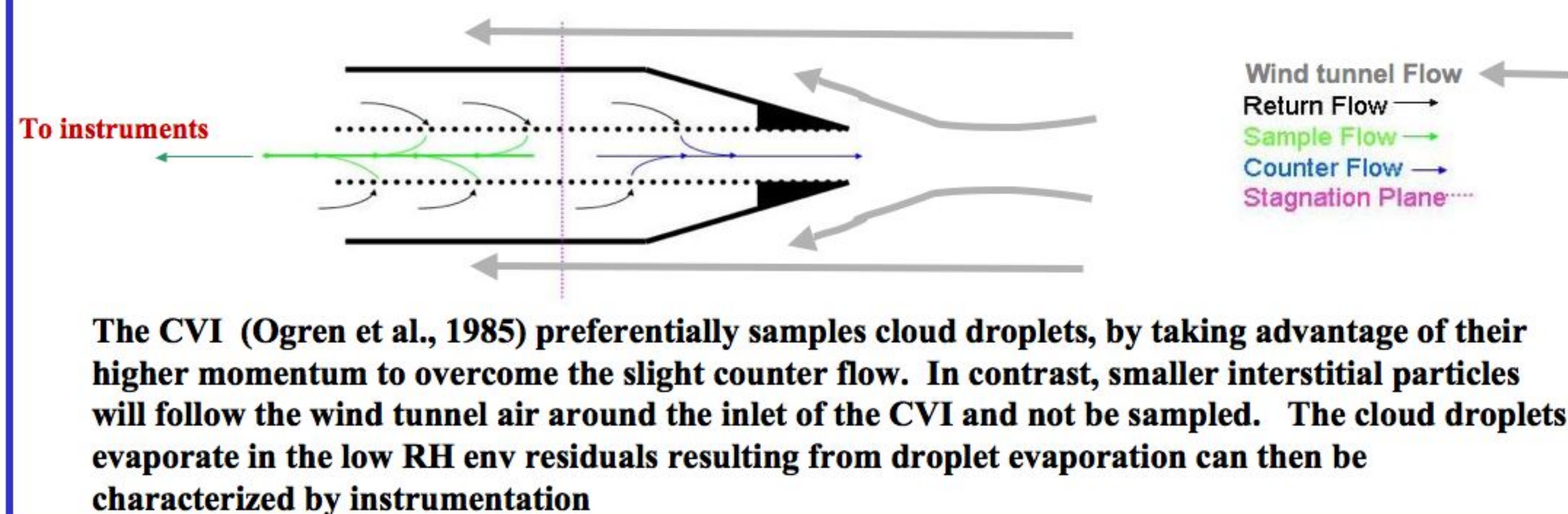


## SCIENTIFIC QUESTIONS

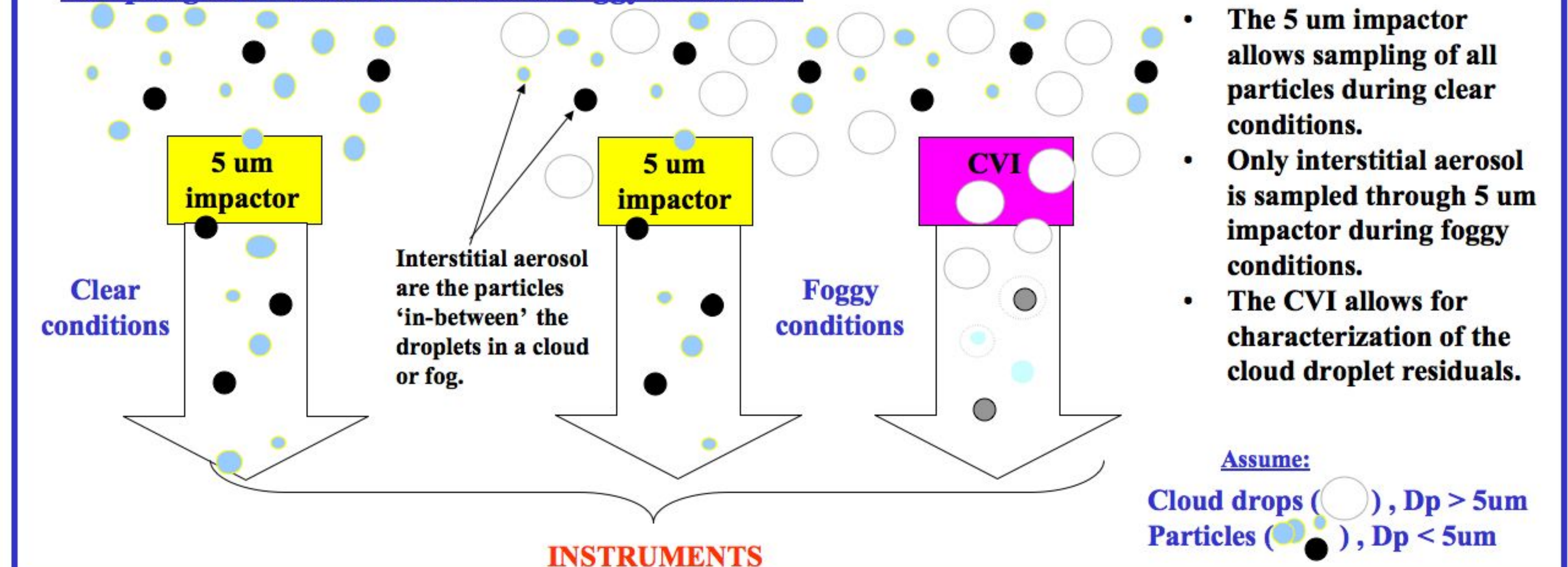
- What are the differences in chemistry between interstitial and activated aerosol?
- What role do organics play in aerosol formation and activation?
- How do clouds change the optical/radiative properties of the aerosol?
- How do the CCN spectra differ between interstitial and activated aerosol?
- Can CCN closure be obtained?



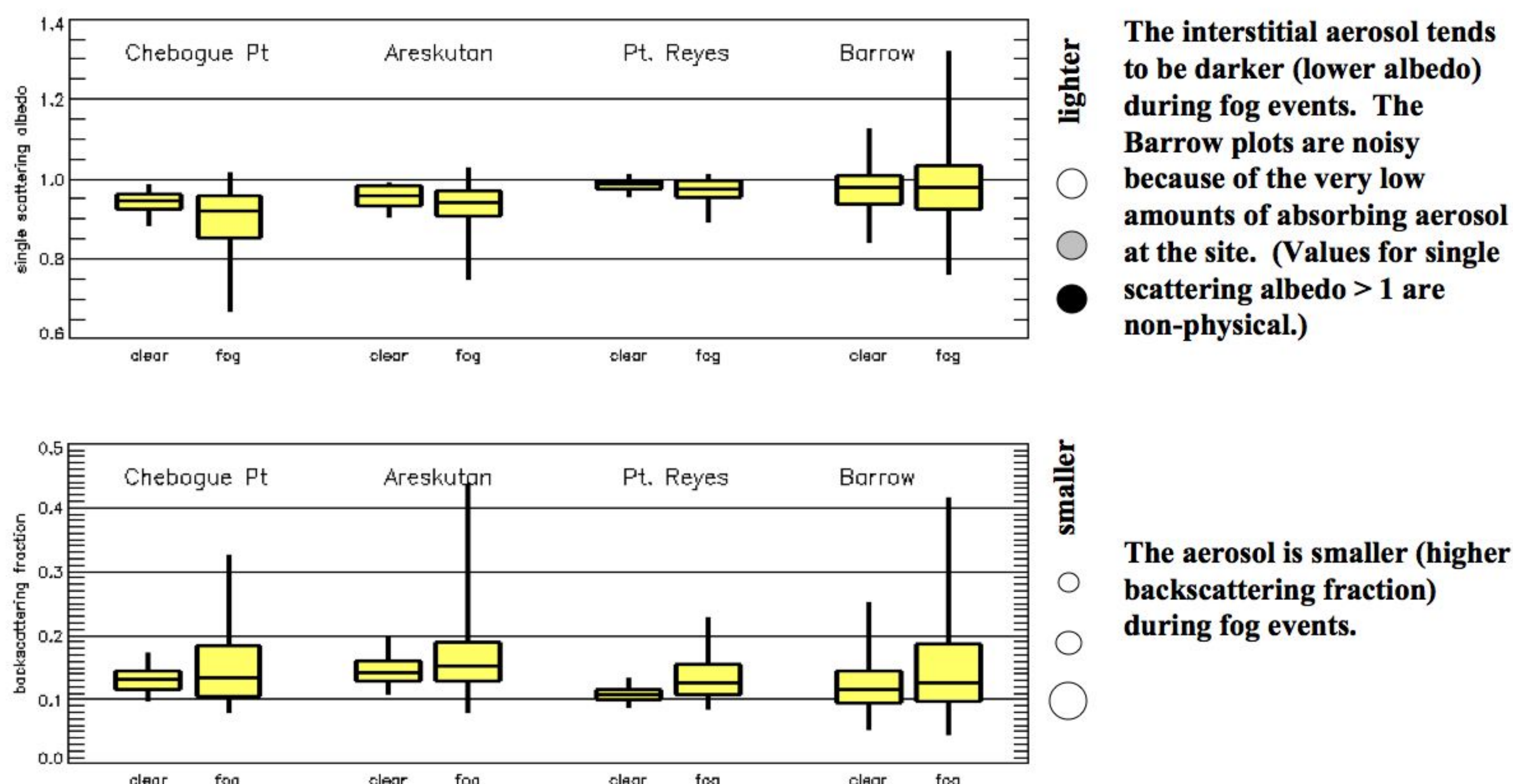
## Counterflow Virtual Impactor (CVI)



## Sampling Schematic for clear and foggy conditions

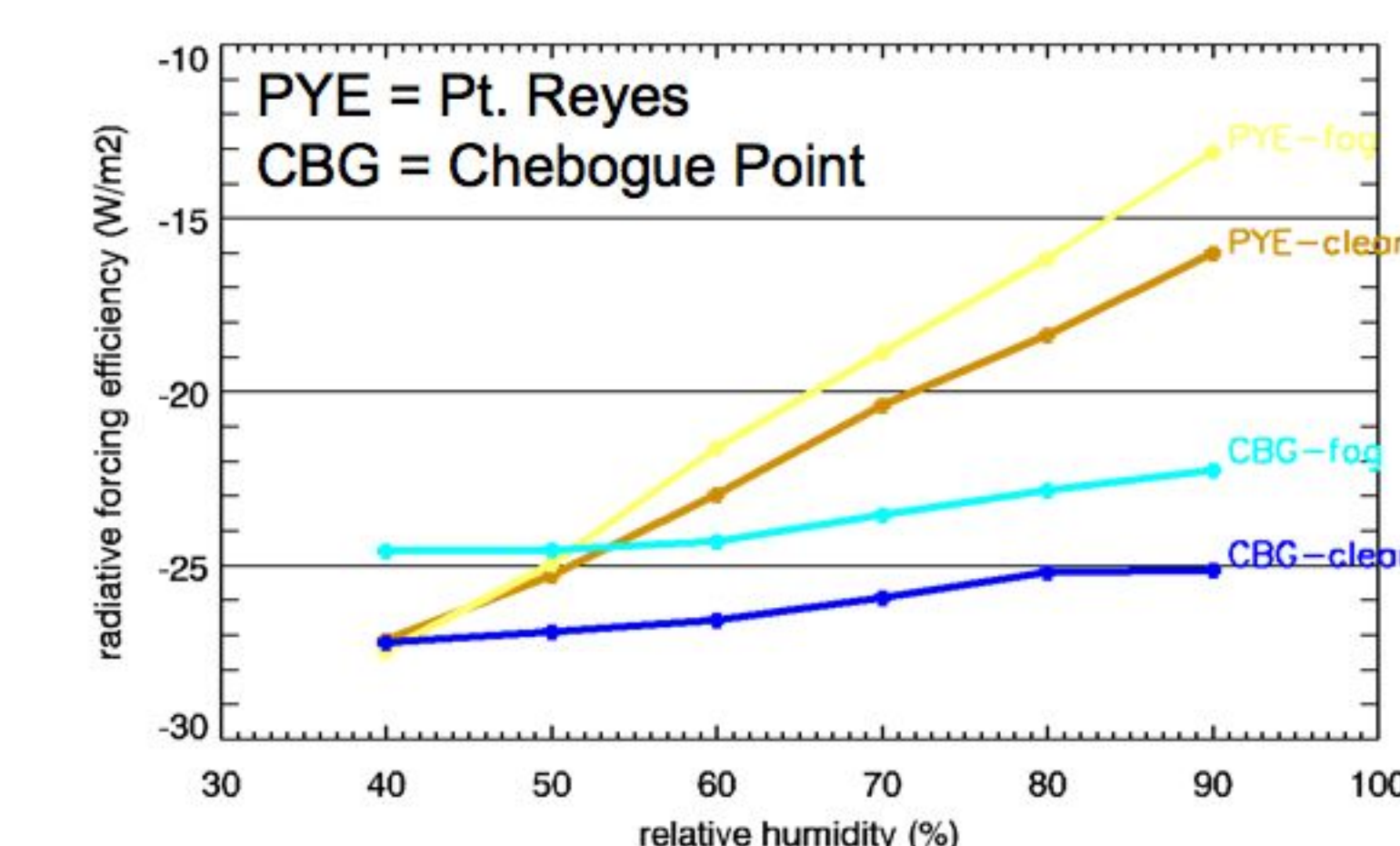


## Influence of fog on aerosol optical properties

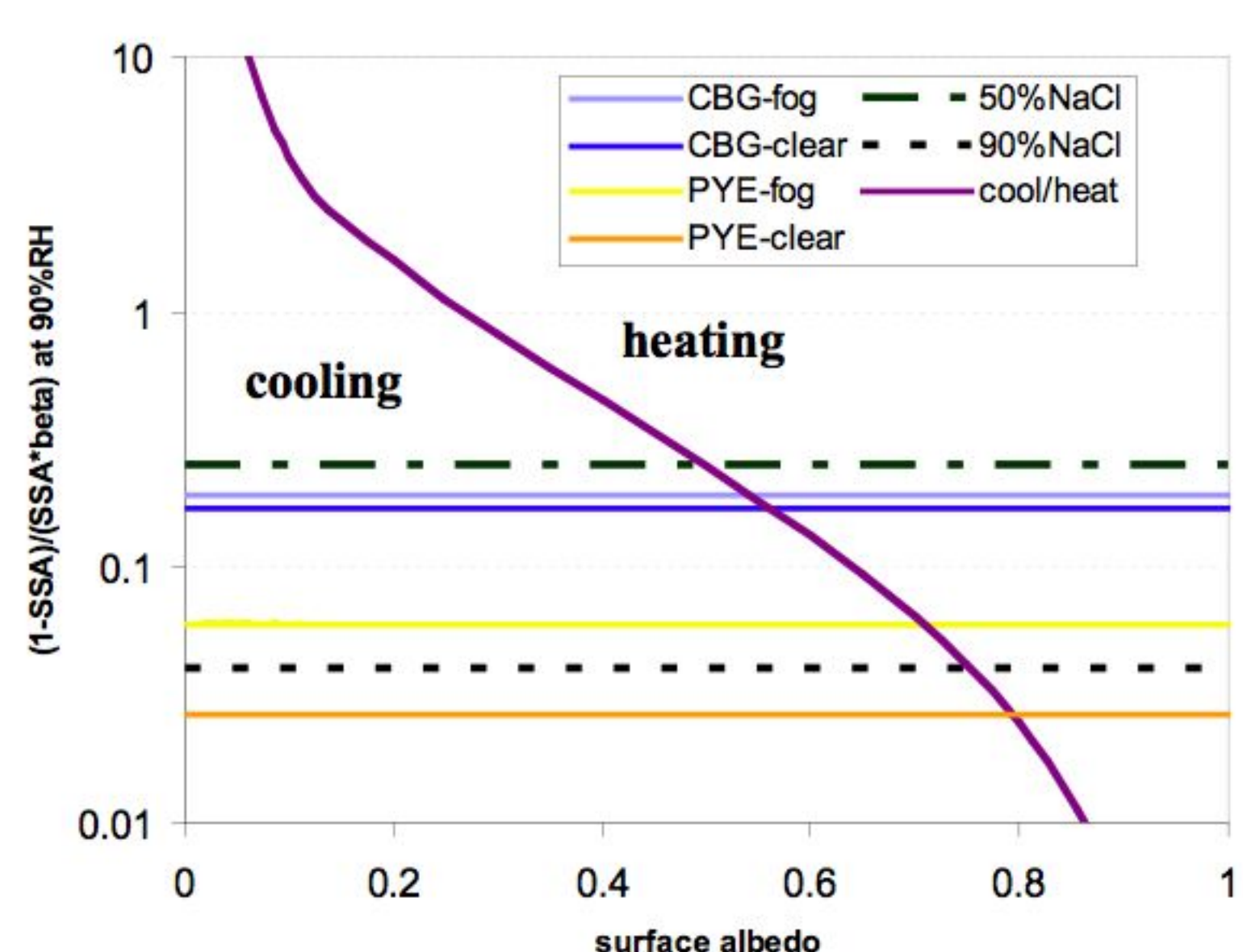


Plots show ambient aerosol for clear conditions and interstitial aerosol for foggy conditions. Presence of fog was determined using IR measurements at Chebogue Point, digitally processed webcam images at Mt Areskutan, and Vaisala present weather detectors at Pt. Reyes and Barrow.

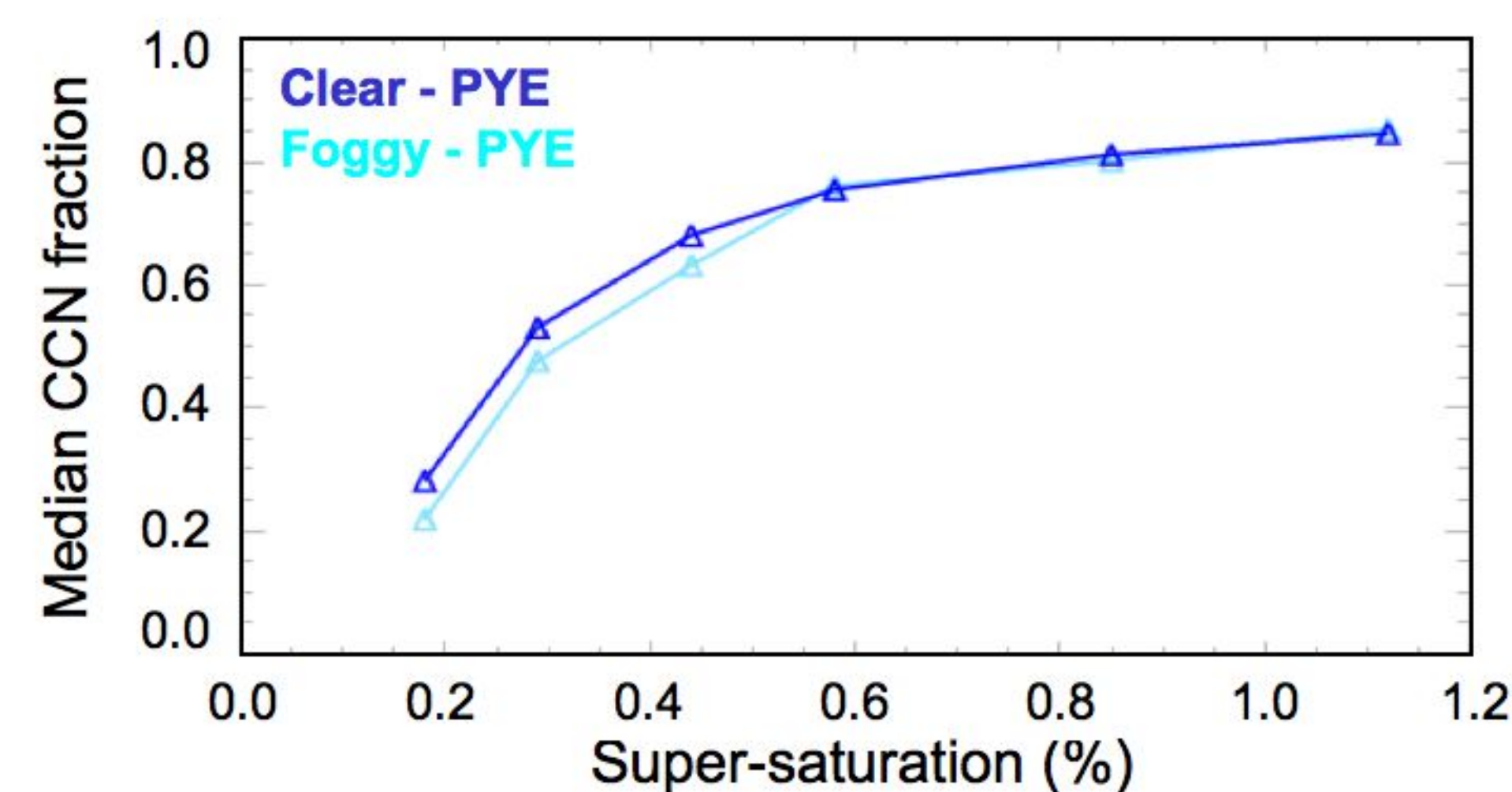
## Fog, aerosol hygroscopicity, and radiative forcing efficiency (RFE)



Fog processing can change the hygroscopicity of the aerosol, and thus influence the top of atmosphere (TOA) RFE of the aerosol as a function of relative humidity. The plot at the left shows that as relative humidity increases, the calculated RFE of the interstitial aerosol tends to be less negative than that of aerosol during clear conditions.



## Changes in CCN fraction during foggy and clear conditions



## Results from Point Reyes (and other sampling sites)

### Interaction with fog changes the optical properties of aerosol.

→ The unscavenged aerosol is darker (lower single scattering albedo) and smaller (higher backscatter fraction, Ångström exponent and lower asymmetry parameter). Additionally, the scavenging results in less atmospheric aerosol.

### These changes in aerosol characteristics can alter their radiative effect.

→ There are slight differences in RFE for unscavenged versus interstitial aerosol. For the two sites where aerosol hygroscopicity was measured, the RFE is significantly different for the fog-processed aerosol, showing the importance of understanding how cloud-aerosol interactions change the water-uptake properties of the particles and thus the particle optical properties at ambient humidity levels.

### The preferential scavenging of scattering aerosol by clouds/fogs may explain the relatively long life time and ubiquity of absorbing aerosol in the atmosphere.

→ Smoke from the 2004 Alaskan forest fires was detected in Norway and Greenland a month after emission (Stohl et al., 2006).  
→ Is the relatively dark aerosol (i.e., low single scattering albedo) that has been observed in some remote locations (e.g., high altitude airplane sampling, Arctic haze), due in part to cloud processing and preferential scavenging of scattering aerosol during transport?

## What to look forward to from the Holme Moss Experiment

### Chemical, physical and optical measurements of aerosol during clear and cloud conditions for an anthropogenically influenced aerosol.

→ The suite of aerosol instrumentation will be very similar to that deployed at Point Reyes, but the aerosol promises to be more varied in composition due to influence from the Leeds and Manchester conurbations.

### Enhanced microphysical cloud measurements

→ The University of Manchester will be deploying multiple *in situ* cloud instruments to really characterize the cloud properties.

### Cloud drop residual measurements and CCN closure studies

→ The CVI inlet should allow for evaluation of the importance of chemistry versus size for the Holme Moss aerosol. It will be interesting to put the results from this study in the context of the current (and historical) debate about the importance of size and chemistry for CCN activity.

## References:

Ogren, J.A., J. Heintzenberg, et al., "In situ sampling of clouds with a droplet to aerosol converter," *Geophys. Res. Lett.* 12: no. 3, 1985.  
Randles, C.A., Russell, L.M., Ramaswamy, V., "Hygroscopic and optical properties of organic sea salt aerosol and consequences for climate forcing," *GRL*, 31, L16108, doi:10.1029/2004GL020628, 2004.  
Stohl, A. et al., "Pan-Arctic enhancements of black carbon aerosol concentrations due to North American boreal forest fires during summer 2004," submitted *J. Geophys. Res.*, 2006.

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